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Edible Coatings to Reduce Postharvest Loss of Harumanis Mango (*Mangifera indica L.*)

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Abstract

Harumanis is type of mango in Indonesia that meets the needs of export or local markets. Harumanis mango have not been able to fully boost the rate of export of this Indonesian fresh fruit due to poor postharvest technology. This condition has an adverse impact as it increases postharvest loss. Thus, in these conditions there must be postharvet handling of harumanis mango, one of which is edible coating made from chitosan with the addition of starch. The difference in the value of amylose and amylopectin from starch resulted in differen results. The aim of this research was to determine the effect of addition of starch types in chitosan edible coating on the postharvest loss of harumanis mango based onthe physico-chemical tests. The experiment used completely randomized design with two factor. The parameters observed were physical test including weight loss, texture, and color. Chemical test including respiration rate, vitamin C, and total soluble solids. The result showed that the addition of starch on chitosan edible coating significantly affected postharvest loss to the results of physical and chemical tests. The best treatment was the addition of starh to edible coating with chitosan because it can provide physical and chemical defense during storage at room temperature.

Introduction

Harumanis is a type of mango in Indonesia that meets the needs of export or local markets. This is due to the high production of *harumanis* mango, fresh with sweet taste, fragrant, and tangy fruit aroma, fine fiber, then thick fruit flesh (Ichsan & Wijaya, 2015). However, *harumanis* mango have not been able to fully boost the rate of Indonesia's fresh fruit export to date. This is due the limitations of the application of postharvest technology to *harumanis* mango. The limitations of postharvest technology of *harumanis* mango not only occurs in the export market, but also occurs in the local market. In general, the way of selling fruits was by placing the fruits in a large box with open conditions, in direct contact with the enviroment. These conditions had a less favorable effect on the state of shelf life and the quality of *harumanis* mango because of the postharvest loss. Postharvest loss is condition when agricultural products experiences loss of yield or weight loss, damage in both chemical and physical state, and low shelf life and comodity usability. This, in return causes the selling value of agricultural products to decline. This situation is shown that at room temperature, amngoes have a short shelf life of around 6-10 days, reaching 14 days at low temperature (Camatari *et al.*, 2017). To increase shelf of fruits, including mangoes, edible coating can be utilized.

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Edible coatings can be made from three different types of materials including hydroloid, lipids, and composites (Fakhouri *et al*., 2007). Chitosan is the second most abundant polysaccharide available in nature and can be obtained from deacetylation reactions from chitin (Aider, 2010). Chitosan is nontoxic, biodegra-dable, renewable, and able to form gels in acidic media through protonation of amine groups (Murni *et al.*, 2013). Making edible coatings made from chitosan combined with starch can improve the mechanical properties of edible coating. The difference levels of amylose and amylopectin content in starch type, to produce different characteristics. Types of starch that are easily found, abundant in nature, and cheap are cassava starch and corn starch. Both amylose and amylopectin content differ where cassava starch contains 17% amylose and 83% for amylopectin, where as corn starch contains 27% amylose and 72% amylopectin. The difference leads to an influence in the formation of films that will affect of the quality of agricultural products. The objective of the research is to develop edible coatings made from chitosan with addition of starch types. The starch types used are cassava starch and corn starch. These are used to verify their impact of usage on the physico-chemical characteristics of the mango of *harumanis* variety.

Methods

The main samples are *harumanis* mango (level of maturity ± 80-85%) from PT. Trigatra Rajasa Situbondo. The components of coating are chitosan, corn starch, cassava starch, acetic acid, aquades, and gliserol.

This experiment used two types of starch; there are corn starch and cassava starch. Treatment variation is the ratio between types of starch and chitosan. As for the 4 treatments, there are *harumanis* mangos which are not coated (control), *harumanis* mango coated with edible coating made from chitosan (P1), *harumanis* mango coated with edible coating made from chitosan plus cassava starch (P2), and *harumanis* mango coated with edible coating made from chitosan plus corn starch (P3).

Fruit sanitation, preparation, and application edible coatings

The sanitization of the mango was carried out by washing with water, and then soaked with banlate liquid for 10 minutes. Next, the mangoes were placed in nets for drying at ambient temperature. Three types of edible coatings were prepared following the procedure by previous research with modifications. The making of edible coating with starch was done separately between chitosan solution and starch solution. Chitosan (3 grams) was dissolved with 1% acetic acid 50 ml, and starch (1 gram) was dissolved in aquades 100 ml. When each solution has dissolved, then chitosan solutions 3% was mixed with starch solutions until homogeneous by heating (± 60 minutes, 50 ^{0}C), later added glycerol 2 ml as a srabilizer. The mangoes that has been sanitized and dried, was then coated each with edible coating with a mastery technique (brush made of nylon material). After that, mangoes were stored at room temperature and observations were carried out for 0, 6, 9, 12 and 15 days.

Procedure of Analysis

The analysis procedure consists of physical test which include weight loss (Athmaselvi *et al.*, 2013), texture (Oliu *et al.*, 2008), and color (Hamzah *et al*., 2013). Chemical test include respiration rate (Azarakhsh *et al.*, 2012), vitamin C and total dissolved solids (Islas-Osuna *et al.*, 2010). All data were analyzed esing the Analysis of Variance (ANOVA) two way. The Duncan test was applied to determine differences among means at a 5% significance level.

Results and Discussion

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Based on **Figure 1**, the effect of adding starch types on chitosan edible coatings to *harumanis* mango weight from day 6 to day 15 had a significant impact (Sig. <0.05). the results of variance showed that the interaction of the addition of starch on chitosan edible coatings to *harumanis* mango weight was not significantly different on day 12 and day 15. This indicates that the addition of starch types on chitosan edible coatings did not significantly impact weight loss. The thicker and denser matrix film will reduce the rate of water displacement as it is more difficult to penetrate

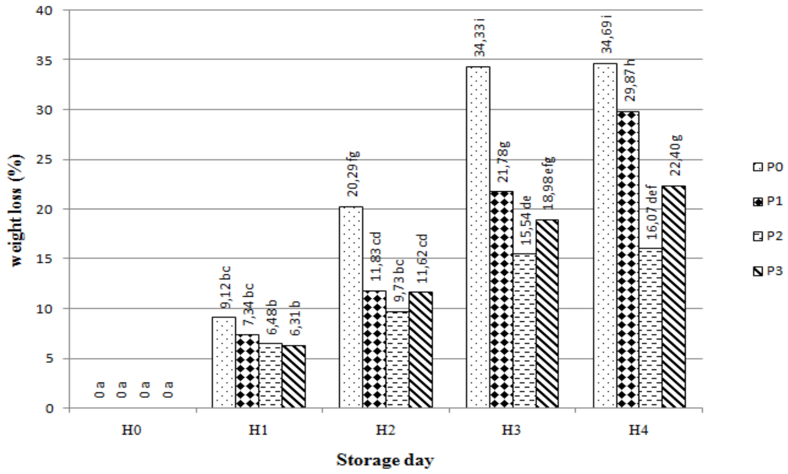

Figure 1. *Weight loss during storage days*

Figure 2 showed that *harumanis* mango texture changed for 15days of storage at room temperature. The effect of the additio of starch types on chitosan edible coatings to *harumanis* mango texture also had a significant impact (Sig. <0.05). the results of starch types on chitosan edible coatings to the texture of *harumanis* mango was not significantly different during obserations on day 6, fay 9, day 12, and day 15. Thick layer resulted in anaerobic espiration as a result of insufficient O_2 concentration in contrast to normal respiration or aerobic respiration. Anaerobis respiration can cause physiological damage that decreases tissue integrity and results in a mushy texture.

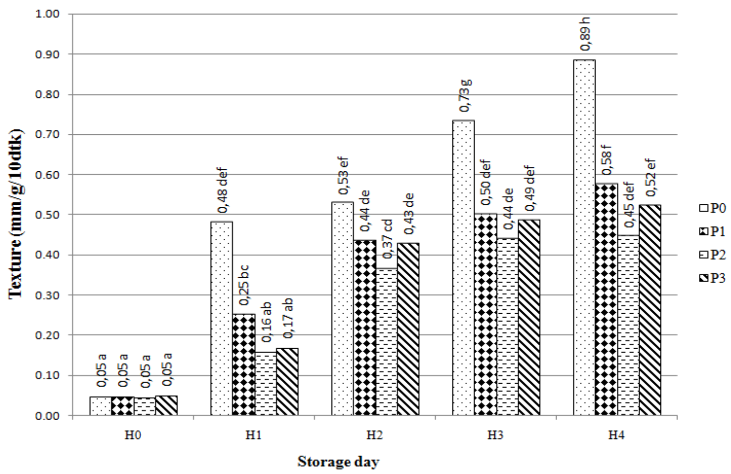

Figure 2. *Texture during storage days*

Measurement of color using CIELAB was designed to match the perception of the human vision by using three components of assessment, namely L*, a*, and b*. **Figure 3** showed that effect of the addition of starch on citosan edible coatings to chroma color of the *harumanis*

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mango also had a significanr impact (Sig. <0.05) when entering day 9 to day 15.*Harumanis* mango not coated with edile coating looked significantly different from the *harumanis* mango coated with edible coating on day 9. The addition of starch to chitosan edible coatings was not significantly different from day 9 to day 15.

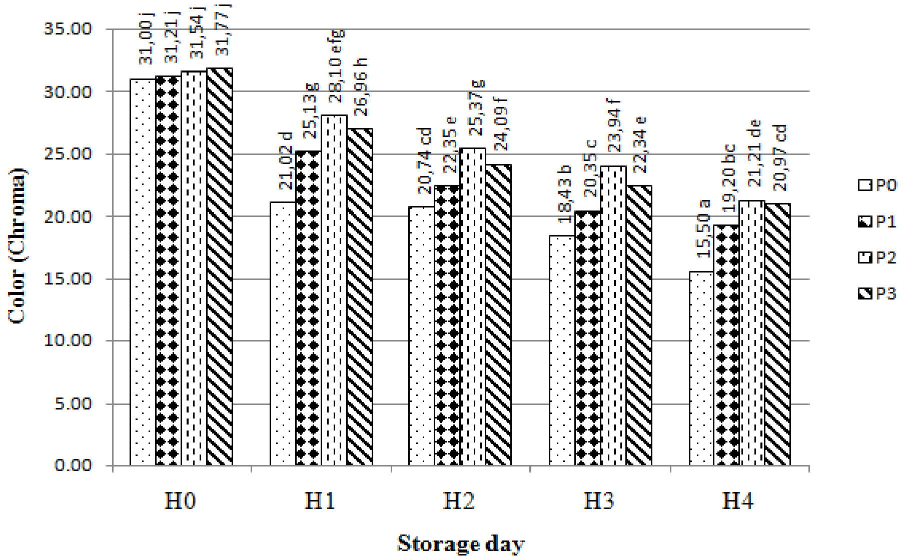

Figure 3. *Chroma during storage days*

Based on **Figure 4**, the effect of the addition of starch on chitosan edible coatings to respiration rate of the *harumanis* mango had a significant impact (Sig. <0.05). there were significant differences in respiration rate between treatmens starting from day 6 to day 15. It was shown that on the day 6, the *harumanis* mango not coated had a high respiration rate, but *harumanis* mango coated with edible had a high respiration in day 9. It showed that the coating can reduce the rate of respiration that occurs.

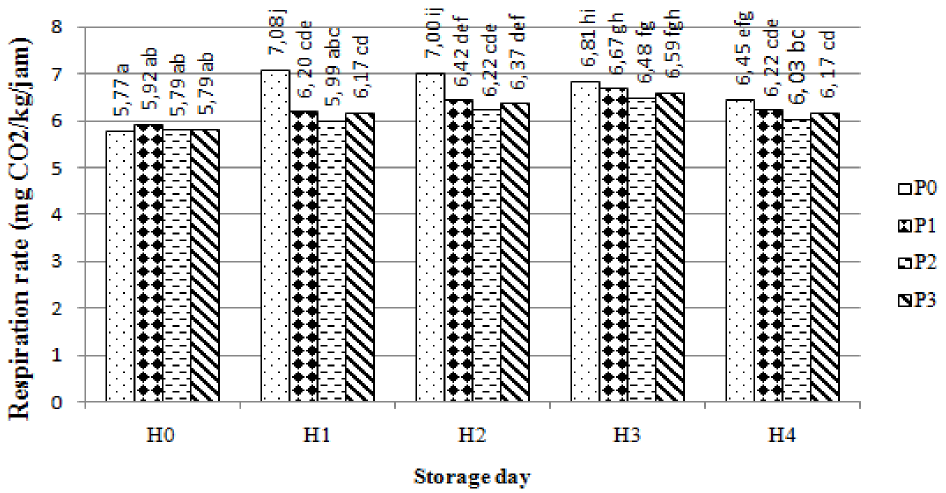

Figure 4. *Respiration rate during storage days*

Figure 5 showed that the effect of starch addition on chitosan edible coatings to vitamin C of *harumanis* mango had a significant impact (Sig. <0.05). the experiment showed significant differences starting on day 6 to day 15. The decrease in Vitamin C was due to decline of organis acids. Therefore, reducing acid is closely related to the function of repiration. As long as respiratiuon takes place during the ripening process of vegetables and fruits, there will be a decrease in organic acids into sugar.

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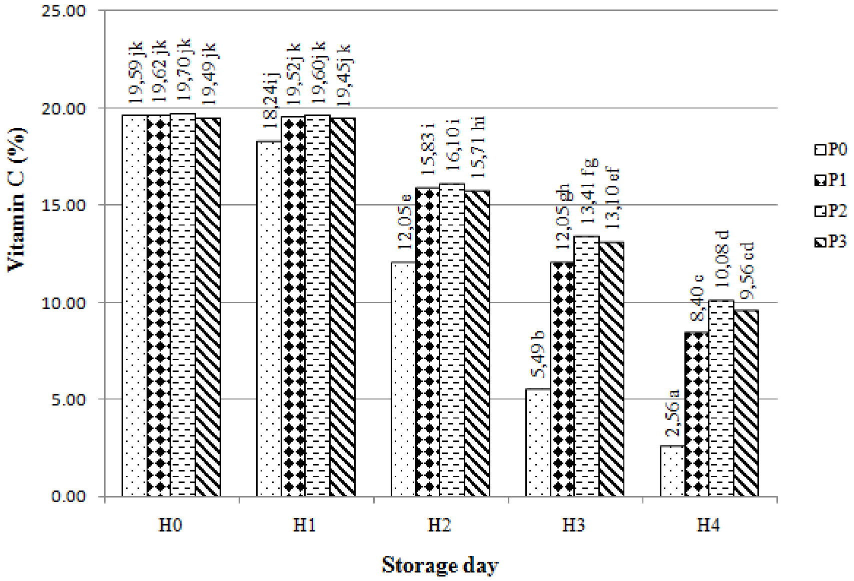

Figure 5. *Vitamin C during storage days*

On **Figure 6**, it was shown the effect of addition of starch types on chitosan edible coatings to total soluble dissolved solids of *harumanis* mango had a significant different impact (Sig. <0.05) occured when entering day 6 to day 15. Total soluble solids tends to increase as it enter ripening, but when in enter decay the total soluble solids will tend to decline.

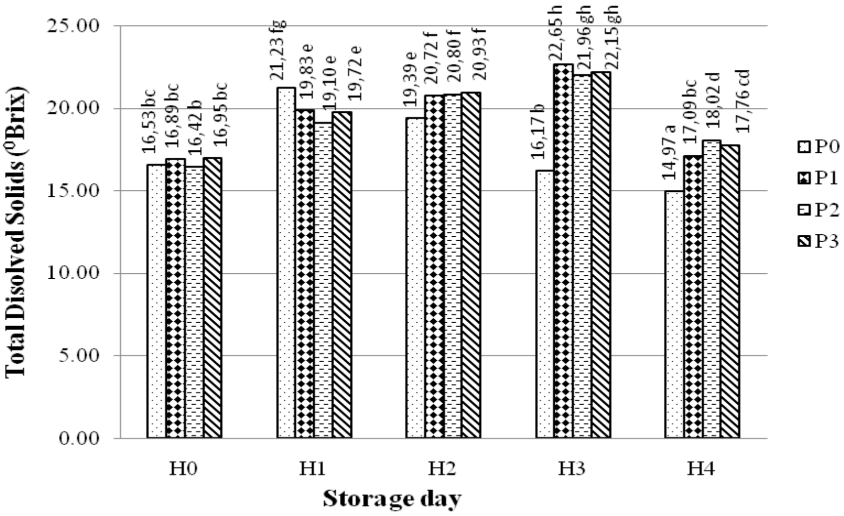

Figure 6. *Total soluble solids during storage days*

Physical appearance of mangoes

Harumanis mango which are not coated with edible coating had a very significant color change for 15 days of storage at room temperature. The color change of *harumanis* mago during storage is the easiest indicator to see the level of maturity and decay. In the phase of entering maturation, the starch content of *harumanis* mango was transformed into glucose. When entering the stage of glucose decay it was transformed into organic acids and volatile on the *harumanis* mango.

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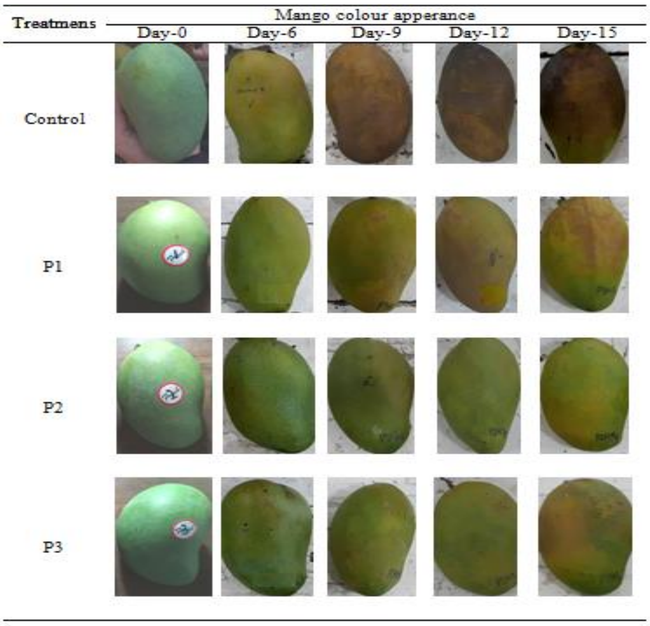

Figure 6 *Mango colors appearance for 15 days of storage*

Based on **Figure 6**, This showed that the addition of starch to chitosan edible coatings (P2 and P3) had better results to reduce postharvest loss in *harumanis* mango than control and P1. However, the type of starch did not make a significant difference, which might be caused by the content of amylose and amylopectin from corn starch and cassava starch having similar values.

Conclusion

The addition of starch to chitosan edible coatings significantly affected postharvest loss to the results of physical ad chemical tests of *harumanis* mango, but the effect due to addition the type of starch on chitosan edible coatings was not significantly different.

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